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Fuels - Tetraethyl lead - Analysis (42563); Fuels -
Antiknock properties (42464)

The knock-limited performance of S reference fuel plus 2 milliliters of triethylthallium per gallon

National Advisory Committee for Aeronautics, Washington, D. C.

U.S. Eng. Unclass. Nov'45 6 table, graph

The vapors of thallium, when introduced into the combustion chamber of an internal combustion engine, are effective as an antiknock agent. On a weight basis, the thallium vapors have several times the antiknock value of tetraethyllead. Triethylthallium proved successful as an additive to S-4 reference fuel in a ratio of 2 ml per gallon.

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THE KNOCK-LIMITED PERFORMANCE OF S REFERENCE FUEL PLUS 2 MILLILITERS OF TRIETHYLTHALLIUM PER GALLON

By Carl L. Meyer

Aircraft Engine Research Laboratory
Cleveland, Ohio

NACA

WASHINGTON

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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

RESTRICTED BULLETIN

THE KNOCK-LIMITED PERFORMANCE OF S REFERENCE FUEL PLUS 2 MILLILITERS OF TRIETHYLTHALLIUM PER GALLON

By Carl L. Meyer

INTRODUCTION

Data reported in reference 1 indicate that the vapors of thallium, when introduced into the combustion chamber of an internal-combustion engine, are effective as an antiknock agent. On a weight basis, the thallium vapors were found to have several times the antiknock value of tetraethyl lead, which was added to the fuel. The amount of thallium vapor necessary to raise the antiknock properties of a gasoline up to exact equivalence with a benzol-gasoline mixture was determined in these engine tests. In view of the encouraging results for thallium vapors reported in reference 1, tests of the antiknock effectiveness of a thallium compound, when added to the fuel, were considered advisable.

As part of an investigation being conducted at the NACA Cleveland laboratory to determine the effectiveness of various compounds as antiknock agents for aviation fuels, sufficient triethylthallium was synthesized for exploratory tests. Knock-limited performance data were obtained in April 1945 in a small-scale single-cylinder engine at two inlet-air temperatures for S-4 reference fuel plus 2 ml triethylthallium per gallon and were compared with similar knock-limited data for S-4 and S-4 plus 2 ml TEL per gallon.

APPARATUS AND TEST PROCEDURE

The tests were conducted with a 17.6 engine. The engine operating conditions were as follows:

Engine speed, rpm	1800
Compression ratio	7.0
Outlet-coolant temperature, °F	212
Inlet-air temperature, °F	250, 100
Spark advance, degrees B.T.C.	30
Injection timing, degrees A.T.C.	60

PRESENTATION AND DISCUSSION OF RESULTS

Figure 1 presents the knock-limited performance of S-4 reference fuel, S-4 plus 2 ml TEL per gallon, and S-4 plus 2 ml triethylthallium per gallon at inlet-air temperatures of 250° F and 100° F. The data, which were obtained during a single operating day, are summarized in table 1.

At the higher inlet-air temperature, the knock-limited power of S-4 was slightly decreased at fuel-air ratios below 0.07 by the addition of triethylthallium but was substantially increased at higher fuel-air ratios. When the inlet-air temperature was reduced to 100° F, the knock-limited power of S-4 was appreciably increased at all fuel-air ratios by the addition of triethylthallium. The test fuel containing the triethylthallium was more sensitive, particularly at lean fuel-air ratios, to changes of inlet-air temperature than either S-4 or S-4 plus 2 ml TEL per gallon. (See table 1(b).) At neither inlet-air temperature did the addition of triethylthallium to S-4 produce power increases comparable with those obtained through the addition of an equal-volume concentration of tetraethyl lead.

Because triethylthallium is a toxic and unstable compound that is difficult to prepare and because the data indicate that it is not comparable with tetraethyl lead as an antiknock agent in the concentration tested, the tests were discontinued. No attempt was made to verify the data of reference 1 as to the effectiveness of thallium vapor as an antiknock agent.

Aircraft Engine Research Laboratory,
National Advisory Committee for Aeronautics,
Cleveland, Ohio.

REFERENCE

1. Egerton, A., and Smith, F. Ll.: On the Phenomenon of Knock in Petrol Engines. Part IV - Experiments on the Behaviour of "Anti-Knocks". Phil. Trans. Roy. Soc. (London), ser. A., vol. 234, no. XLV, July 30, 1935.

TABLE 1. - SUMMARY OF TEST DATA

[17.6 engine; compression ratio, 7.0; engine speed, 1800 rpm; outlet-coolant temperature, 212° F; spark advance, 30° B.T.C.; injection timing, 60° A.T.C.]

(a) Relative performance

Test fuel	imep ratio = imep of (S-4 + additive) / imep of S-4				
	Fuel-air ratio				
	0.065	0.07	0.085	0.10	0.11
Inlet-air temperature, 250° F					
S-4 reference fuel	1.00	1.00	1.00	1.00	1.00
S-4 + 2 ml triethylthallium/gal[a]	.96	1.00	1.18	1.19	1.20
S-4 + 2 ml TEL/gal	1.37	1.42	1.40	1.36	1.37
Inlet-air temperature, 100° F					
S-4 reference fuel	1.00	1.00	1.00	1.00	1.00
S-4 + 2 ml triethylthallium/gal[a]	1.08	1.13	1.23	1.22	1.20
S-4 + 2 ml TEL/gal	1.42	1.40	1.37	1.41	1.40

[a]F-3 rating, S + 0.07 ml TEL per gallon.

(b) Relative temperature sensitivity

Test fuel	Relative temperature sensitivity[a]				
	Fuel-air ratio				
	0.065	0.07	0.085	0.10	0.11
S-4 reference fuel	1.00	1.00	1.00	1.00	1.00
S-4 + 2 ml triethylthallium/gal	1.10	1.13	1.04	1.03	1.00
S-4 + 2 ml TEL/gal	1.04	.99	.98	1.04	1.02

[a]Relative temperature sensitivity = $\frac{\text{imep ratio (inlet-air temperature, 100° F)}}{\text{imep ratio (inlet-air temperature, 250° F)}}$

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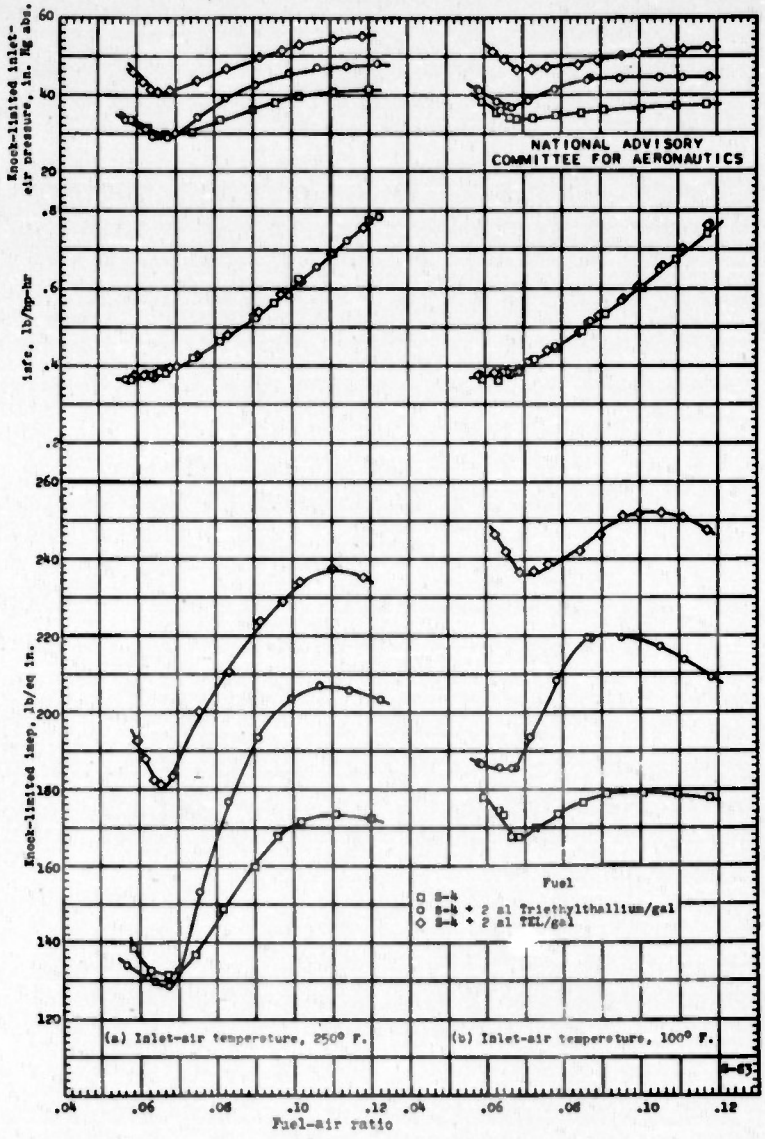

Figure 1. - Comparison of the knock-limited performance of S-4 reference fuel plue 2 ml triethylthallium per gallon with the knock-limited performance of S-4 and S-4 plue 2 ml TEL per gallon. 17.6 engine; compression ratio, 7.0; engine speed, 1500 rpm; outlet-coolant temperature, 212° F; spark advance, 30° B.T.C.; injection-timing, 60° A.T.C.

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